

What is claimed is:

1. A method for forming a hollow FRP article by internal pressure molding, comprising:

positioning a FRP prepreg on a periphery of an  
5 airtight internal-pressure holding tube;

inserting a composite body including said internal-pressure holding tube and said prepreg into a vacuum chamber containing a forming die;

evacuating said vacuum chamber in an isolation state  
10 where said composite body and said forming die do not contact each other; and

clamping said forming die to bring said forming die and said composite body into contact with each other and heating said forming die with an application of pressure  
15 to an inside of said internal-pressure holding tube after completion of said evacuating step.

2. The FRP hollow article forming method according to claim 1, wherein said prepreg positioning step comprises:

20 covering a mandrel with said internal-pressure holding tube; and

wrapping said FRP prepreg around said periphery of said internal-pressure holding tube.

3. The FRP hollow article forming method  
25 according to claim 2, wherein said clamping and heating

step comprises applying pressure to said inside of said internal-pressure holding tube through air passages formed on said mandrel.

4. The FRP hollow article forming method according to claim 1, wherein said prepreg positioning step comprises:

covering a mandrel with said internal-pressure holding tube;

wrapping said FRP prepreg around said periphery of said internal-pressure holding tube; and

removing said mandrel after said wrapping step.

5. The FRP hollow article forming method according to claim 4, wherein said clamping and heating step comprises applying pressure to said inside of said internal-pressure holding tube through an air-injecting mouth piece fixed to an open end of said internal-pressure holding tube after said mandrel is removed.

6. An apparatus for forming a hollow FRP article by internal pressure molding, comprising:

a vacuum chamber;

a forming die positioned in said vacuum chamber;

a vacuum-chamber opening/closing mechanism for opening and closing said vacuum chamber;

a composite-body support device for supporting a composite body without making said composite body come

into contact with said forming die in a state where said forming die is opened by said vacuum-chamber opening/closing mechanism, said composite body including an airtight internal-pressure holding tube and a prepreg  
5 fitted on said airtight internal-pressure holding tube;

an evacuation system for evacuating said vacuum chamber;

an internal-pressure supplying device for applying pressure to an inside of said internal-pressure holding  
10 tube of said composite body which is supported by said composite-body support device; and

a controller for actuating said vacuum-chamber opening/closing mechanism to clamp said forming die to thereby bring said forming die and said composite body  
15 into intimate contact with each other, and for heating said forming die with an application of pressure to said inside of said internal-pressure holding tube after said vacuum chamber is evacuated by said evacuation system.

7. The FRP hollow article forming apparatus  
20 according to claim 6, wherein said composite body is obtained by covering a mandrel with said internal-pressure holding tube and wrapping said FRP prepreg around a periphery of said internal-pressure holding tube.

8. The FRP hollow article forming apparatus  
25 according to claim 7, wherein said mandrel comprises an

axial air passage and at least one radial air passage,  
and wherein said internal-pressure supplying device  
comprises:

an intermediate movable nozzle which is removably  
5 inserted into said axial air passage and includes a  
one-way valve for preventing air from flowing into said  
vacuum chamber;

a forced valve-opening nozzle which is removably  
inserted into said forced valve-opening nozzle, said  
10 one-way valve being opened by an insertion of said forced  
valve-opening nozzle into said intermediate movable  
nozzle; and

an internal-pressure supplying source for  
supplying compressed air to said forced valve-opening  
15 nozzle.

9. The FRP hollow article forming apparatus  
according to claim 6, wherein said composite body is  
obtained by covering a mandrel with said internal-  
pressure holding tube, wrapping said FRP prepreg around  
20 a periphery of said internal-pressure holding tube, and  
thereafter removing said mandrel from said composite  
body.

10. The FRP hollow article forming apparatus  
according to claim 9, wherein said mandrel comprises an  
25 axial air passage and at least one radial air passage,

and wherein said internal-pressure supplying device comprises:

an intermediate movable nozzle which is removably inserted into said axial air passage after said removal  
5 of said mandrel from said composite body, and includes a one-way valve for preventing air from flowing into said vacuum chamber;

a forced valve-opening nozzle which is removably inserted into said forced valve-opening nozzle, said  
10 one-way valve being opened by an insertion of said forced valve-opening nozzle into said intermediate movable nozzle; and

an internal-pressure supplying source for supplying compressed air to said forced valve-opening  
15 nozzle.

11. The FRP hollow article forming apparatus according to claim 6, wherein said composite-body support device comprises a cantilever support base for supporting said composite body in a cantilever fashion.

20 12. The FRP hollow article forming apparatus according to claim 6, wherein said composite-body support device is mounted to a lower-die table which supports a lower die of said forming die thereon, and

wherein at least a part of said composite-body  
25 support device is biased upwards, toward an upward moving

limit thereof, by a biasing device so that said composite body, which is supported by said composite-body support device, does not contact said lower die.

13. The FRP hollow article forming apparatus  
5 according to claim 6, wherein said forming die and said composite body are designed for manufacturing a golf club shaft.

14. The FRP hollow article forming apparatus  
10 according to claim 11, wherein said composite body is obtained by covering a mandrel with said internal-pressure holding tube and wrapping said FRP prepreg around a periphery of said internal-pressure holding tube;

wherein said cantilever support base includes an inner support portion and an outer support portion which  
15 are positioned apart from each other in an axial direction of said composite body;

wherein said inner support portion includes a half-cylindrical recess having a radius corresponding to a half of an outer diameter of a large-diameter end of  
20 said mandrel, a portion of said mandrel in a vicinity of said large-diameter end being positioned in said half-cylindrical recess; and

wherein said outer support portion includes a cantilever through hole which is greater in diameter than  
25 said large-diameter end of said mandrel so that only an

upper edge of said outer support portion in said cantilever through hole comes in contact with said large-diameter end of said mandrel from above.

15. The FRP hollow article forming apparatus  
5 according to claim 14, wherein said composite-body support device further comprises an anti-deflection support base, positioned inside said vacuum chamber, for subsidiarily supporting a small-diameter end of said composite body to prevent said small-diameter end from  
10 developing deflections.

16. The FRP hollow article forming apparatus according to claim 15, wherein said lower-die table is guided in a vertical direction to be movable vertically with respect to an upper die fixed to an inner surface  
15 of said vacuum chamber.